

SUPER-BLOCK™ Combinations

Part Number	Op Amps	Comparators	Reference	Mux	Comments
LM10	1		0.2V to ($V^+ - 1$)		Ref $\pm 5\%$
LM392	1	1			
LM604	4			1	4 Δ inputs, 1 muxed output
LM611	1		1.2V to 6.3V		Ref $\pm 2\%$
LM613	2	2	1.2V to 6.3V		Ref $\pm 2\%$
LM614	4		1.2V to 6.3V		Ref $\pm 2\%$

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Each of the SUPER-BLOCK™ devices contains one or more op amps (similar to the LM324, except in the case of the LM10) in addition to at least one other function. All the op amps and comparators can operate from a single supply, as their input ranges include ground. The output ranges of the op amps extend within 1V of ground when sinking a few mA, and within 0.2V (typ.) when sinking less than 1 μ A (except the LM604 mux-amp, which is guaranteed to swing within 0.7V of ground in this light-load condition). Similar to the LM339, the comparator's outputs are open-collector, to be pulled up to a convenient logic-high level.

The references used in these components have adjustable output voltages, set with two resistors. The LM10's reference can be programmed for an output voltage of between 200 mV and ($V^+ - 1$ V), referred to V^- , when operated in a series (voltage-supplied) mode. In a shunt mode, with the reference output tied to V^+ , the reference output can be used to set the op amp's supply voltage.

The shunt references in the LM611, LM613, and LM614 are similar to the adjustable LM385 reference, and will operate from a supply current of 16 μ A to 10 mA, and can be programmed to deliver a 1.24V to 6.3V output, independent of the supply voltage used by other parts of the IC. The LM613 and LM614 reference outputs are referred to the IC's ground (or V^-) pin; both the anode and cathode of the LM611 reference are available to allow the reference to be used in a floating mode.

The LM604 contains four op amps along with a digitally-programmed multiplexer which selects the output of 1 of the 4 op amps. Chip-select and enable functions can also be used to put the output into a high-impedance state.

SUPER

LM10

The LM10 and an internal 1.1V or as mV of the output can specified for and current ratings.

Op Amp
Offset
Bias C
Supply
Gain-B

LM392

The LM392 saturated operationally designed monomode from split supply dual op amp

Op Amp
Offset V
Bias Cu
Supply C
Gain-B

LM604

The LM604 is a multiplexer signals, providing output which number of m are controlled has excellent signal multiplexing blocks and filters

Op Amp
Offset V
Bias Curr
Supply C
Gain-Bar
Slew Rat
Output C

SUPER-BLOCK GENERAL DESCRIPTIONS

LM10

The LM10 is a monolithic linear IC consisting of a precision reference, an adjustable reference buffer and an independent, high quality op amp. The unit can operate from a total supply voltage as low as 1.1V or as high as 40V, drawing only 270 μ A (typ.). A complementary output stage swings within 15 mV of the supply terminals or will deliver ± 20 mA output current with ± 0.4 V saturation. Reference output can be as low as 200 mV. This IC is recommended for portable equipment and is completely specified for operation from a single power cell. In contrast, high output-drive capability, both voltage and current, along with thermal overload protection, suggest it in demanding general-purpose applications.

Op Amp:

Offset Voltage ≤ 4 mV
Bias Current ≤ 2 nA
Supply Current ≤ 500 μ A
Gain-Bandwidth Product 100 kHz

Reference:

Initial Value 200 mV \pm <5%
Line Regulation ≤ 80 ppm/V
Suitable for Loads ≤ 10 mA

LM392

The LM392 consists of 2 independent building block circuits. One is a high gain, internally compensated operational amplifier, and the other is a precision voltage comparator. Both have been specifically designed to operate from a single supply of 2 to 32V. Both circuits have input stages with common-mode range extending down to ground when operating from a single supply voltage. Operation from split supplies is also possible. The device has a standard dual pinout, the same as the LM358 dual op amp and the LM393 dual comparator.

Op Amp

Offset Voltage ≤ 5 mV
Bias Current ≤ 250 nA
Supply Current < 1 mA @ 5V supply
Gain-Bandwidth Product 0.8 MHz

Comparator

Offset Voltage ≤ 5 mV
Bias Current ≤ 250 nA
Response Time 1.5 μ s

LM604

The LM604 Mux-Amp is an op amp with four selectable differential inputs, combining the functions of a multiplexer with an op amp. The LM604 can select, buffer, and amplify one of four different input signals, providing a complete system for multiplexing analog signals. It also has the unique Bi-State output which allows two or more Mux-Amps to be connected together at their outputs to increase the number of multiplexed channels. Channel selection and the Bi-State (Active and Disabled) output are controlled by internal logic that interfaces directly to a microprocessor. In addition, the LM604 has excellent AC and DC op-amp specifications and is internally compensated. Applications include signal multiplexing and linear circuits that are controlled by digital signals (e.g. programmable gain blocks and filters).

Op Amp:

Offset Voltage ≤ 3 mV
Bias Current ≤ 80 nA
Supply Current ≤ 9 mA
Gain-Bandwidth Product ≥ 6 MHz
Slew Rate ≥ 2 V/ μ s
Output Can Drive 600 Ω

Multiplexer:

Enable Time ≤ 4 μ s
Disable Time ≤ 2 μ s
Channel-Switching Time ≤ 5.5 μ s
Channel-to-Channel Isolation 100 dB
TTL Inputs for Mux Control

LM611, LM614

The LM611 contains an adjustable voltage reference and a single-supply operational amplifier; the LM614 contains the same reference but with four single-supply op amps. The voltage reference is a three-terminal shunt-type bandgap similar to the adjustable LM185, but with improved voltage accuracy of better than 2% for the commercial grade, trimmed to better than 0.4% for the prime-grade device. The reference features operation over a current range of 16 μ A to 20 mA, low dynamic impedance, and broad capacitive load tolerance range. The op amp is similar to the LM324, but with improved slew rate and power bandwidth. Its input voltage range extends to ground when operated from a single supply.

Op Amp:

Offset Voltage ≤ 5 mV
Bias Current ≤ 35 nA
Supply Current ≤ 300 μ A (LM611)
Supply Current ≤ 1 mA (LM614)
Gain-Bandwidth Product 0.8 MHz
Slew Rate ≥ 0.5 V/ μ s

Reference:

Initial Voltage $1.244\text{V} \pm <2\%$
Ave. Drift ≤ 20 ppm/ $^{\circ}$ C (Prime grades)
Adjust Range 1.2V to 6.3V

LM613

The LM613 contains an adjustable voltage reference, two single-supply operational amplifiers, and two single-supply comparators. The reference and op amps are as described above for the LM611 and LM614. The comparators are similar to those in the LM339 and, like the op amps, have an input range that extends to ground when operated from a single supply.

Op Amps and Reference:

(see LM611 & LM614 description)

Comparators:

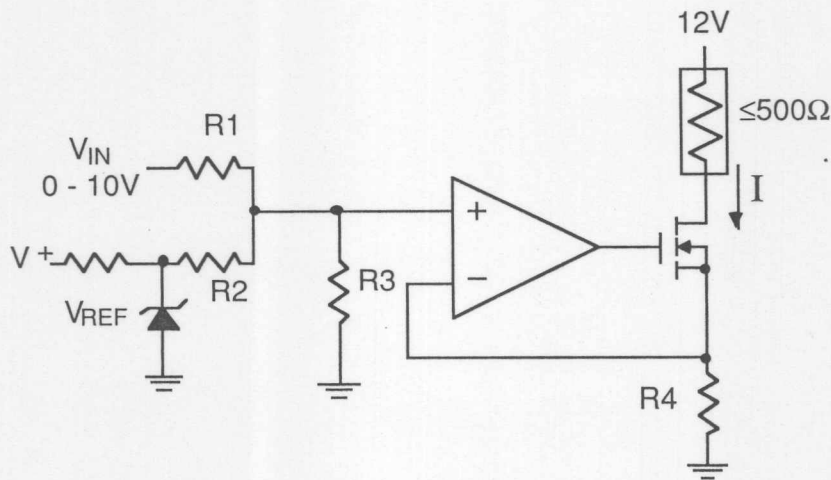
Offset Voltage ≤ 5 mV
Bias Current ≤ 35 nA
Response Time 1.5 μ s

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Current Sink with Scaling and Offset



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An additional reason for using the buffered current sink of circuit B is that it offers a greater compliance range. When V_{IN} is at its maximum level the 500Ω load is conducting 20 mA; on a 12V supply, this leaves only 2V for the current sink driver.

Since the circuit's input voltage is 0 to 10V, and the maximum voltage allowed across the current sense resistor is 2V, the input voltage must be prescaled before being applied to the op amp input. In addition, the minimum load current is to be 4 mA when $V_{IN} = 0V$; this requires that an offset be added to the input voltage.

The circuit shown above uses $R4$ as the current sense resistor. The prescaling with offset is done with $R1$, $R2$, and $R3$:

$$I = \frac{V_{IN} \times X + V_{REF} \times Y}{R4}$$

where

$$X = \frac{1/R1}{1/R1 + 1/R2 + 1/R3}$$

and

$$Y = \frac{1/R2}{1/R1 + 1/R2 + 1/R3}$$

Op Amp

Per Pkg.
Input Ra
Offset V
Bias Cur

Reference

Type
Adj. Rang
Tolerance

Addtl. Fea

* Ranges fo

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an op amp and
reference, the L
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SUPER-BLOCKS™ With Op Amp and Reference

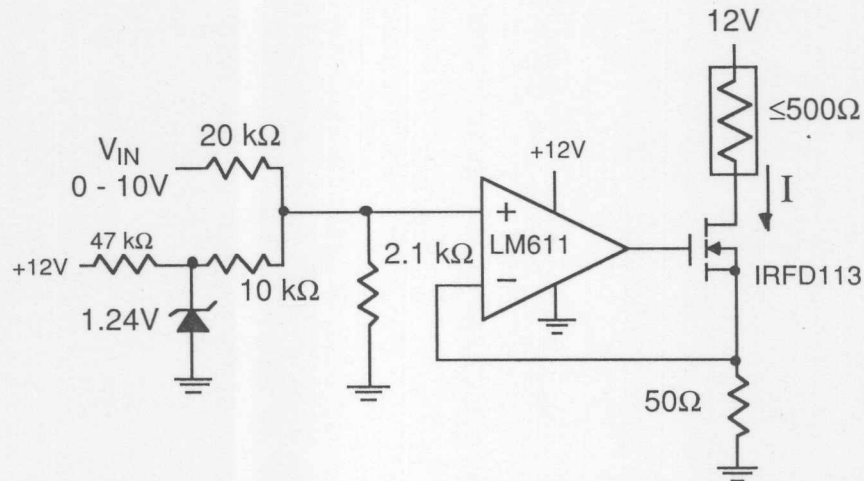
Op Amp(s)	LM10	LM611	LM613	LM614
Per Pkg.	1	1	2	4
Input Range* (V)	0 to 4.15	0 to 3.6	0 to 3.6	0 to 3.6
Offset Voltage	≤4 mV	≤5 mV	≤5 mV	≤5 mV
Bias Current	≤30 nA	≤35 nA	≤35 nA	≤35 nA
<u>Reference</u>				
Type	shunt	series	series	series
Adj. Range (V)	0.2 to (V ₊ -1)	1.2 to 6.3	1.2 to 6.3	1.2 to 6.3
Tolerance	≤±5%	≤±2%	≤±2%	≤±2%
<u>Addtl. Features</u>		Floating Reference	Incl. Two Comparators	

* Ranges for 5V supply

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The current sink could be based on any of the SUPER-BLOCKS™ shown above, which include both an op amp and reference. However, since the minimum voltage across R4 (0.2V) is controlled by the reference, the LM10 reference's 5% tolerance, which cannot be trimmed by the user, will directly affect this offset. It is better to use the higher reference voltage found in the LM611/613/614 (which also has a tighter tolerance than the LM10) and divide it down to the correct level, trimming as necessary. Since only one op amp is needed, the LM611 will be the best choice.

4-to-20 mA Current Sink Uses LM611



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To allow plenty of output compliance, R4 is chosen to be 50Ω for a maximum voltage drop of 1V at 20 mA. Using the 1.24V reference, X becomes 0.08 and Y becomes 0.16, so that

$$R1 = 20 \text{ k}\Omega$$

$$R2 = 10 \text{ k}\Omega$$

$$R3 = 2.1 \text{ k}\Omega$$

voltage proportion @ 4mA $V = 0.2V$

$$\frac{0.2}{1.24} \approx 0.161$$

at 20mA $V = 1V$
 0.8 comes from variable volts

$$\frac{0.8}{10V_{up}} = \underline{\underline{0.08}}$$

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